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REFINEMENT OF SAND

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An acid method for the refinement of sand impurities using orthophosphoric and sulfuric acid is proposed. The developed method makes it possible to decrease the iron oxide content by a factor of 10.

The quality of the raw materials, especially quartz sand, which is usually determined by the content of pigment oxides, especially trivalent iron oxide, is a determining factor in the production of high-quality optical glass, cut glass, glass for laser technology, and glaze pigment of a high degree of whiteness and color sharpness.

The difficulty of quartz sand refinement consists in the fact that the iron oxides in sand are present in different impurities, i.e., in free impurity minerals, in impurity minerals joined to the quartz grains, in impurities located inside the grains, in iron-containing mineral films on the grain surface, and in structural impurities. In it especially difficult to extract the iron contained in mineral films on the grain surface and in impurities inside the quartz grains. The iron-containing surface films on grains penetrate into the quartz grains along hollows and cracks, which makes it difficult and sometimes impossible to remove them by washing and mechanical attrition of sand. The extraction of iron from internal mineral inclusions requires preliminary destruction of grains up to complete separation of the inclusions from the quartz grains and their subsequent removal from the pulverized sand.

Quartz sands from different quarries have different chemical composition, therefore, there is not yet a single method for purification of silicate materials, including quartz sand, from pigment oxides of iron, titanium, aluminum, etc.

According to some researchers, the iron content can be decreased by treating the ceramic material with 0.24% hydrosulphuric acid: iron oxide is transformed into iron sulfide and in order to remove the latter, the material is treated with 0.04% hydrochloric acid. In both cases, the treatment is performed at 20°C for 3 h (Japan patent 17668). The iron oxide in ceramic material decreases from 0.54 to 0.22% (nearly 2.5 times lower).

There is a method of obtaining high-purity quartz sand by treating a certain fraction (below 0.5 mm) with 5 – 20% hydrochloric acid or 2 – 100% sulfuric acid at a temperature of 70 – 100°C for 2 h. After that, the material is filtered and treated with organic solvents (acetone, toluene, ethyl alcohol) to dissolve the chlorides. Using this method, the iron content could be decreased from 0.2 to 0.0045%, and the content of heavy metal oxides was brought down to 0.0002% (East German patent 120860).

There is a known method of mechanical treatment of sand in the presence of zinc or sodium hydrosulfite and sulfuric or hydrofluoric acid. The treatment is performed in three stages for 1 – 20 min. After each stage the iron content gradually decreased, and as a consequence of the three-stage treatment it was reduced from 0.19 to 0.03% (Great Britain patent application 8135329).

Another known method consists in decreasing the content of iron oxide in quartz by milling and treating it with 20% hydrochloric acid, which makes it possible to decrease the iron oxide content from 0.007 to 0.0005%. Quartz refined in this manner is used for production of glass used in laser technology (Romanian patent 92746).

There is a method for decreasing the iron oxide content in raw materials and improving of the whiteness of silicate and aluminosilicate materials which is based on the use of an aqueous solution of the following composition (%): 1.00 – 3.50 mineral acid, 0.05 – 0.80 hydroxylamine sulfate. The use of this method makes it possible to decrease the iron oxide content to 0.13 – 0.30% and to increase the degree of whiteness to 67 – 74% (USSR author's certificate 1323550).

Several authors suggested the method of heat treatment of quartz sand at a temperature of 1500 – 1600°C for 4 h with subsequent treatment with 5 per cent oxalic acid at the temperature of 60°C for 2 h. As a consequence, the iron oxide content in the sand decreased to 0.0028% (USSR Author's Certificate 806623).

There is a method for decreasing the iron oxide content in quartz sand which includes magnetic separation, boiling in 17% hydrochloric acid, neutralization, and drying at a tem-

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perature of 120 – 150°C. All of this makes it possible to decrease the iron oxide content by a factor of 2 – 5 [1].

Our experiments are also based on treatment of sand with mineral acids. The quartz sand taken for refinement had an initial iron oxide content of 0.095% and was treated with 10% orthophosphoric acid at the temperature of 20°C for 1 h with a ratio between liquid (L) and solid (S) equal to 2 : 1. Then, to dissolve the iron phosphate formed, the pulp was treated with 20% hydrochloric acid and neutralized. The resulting sand contained 0.04% iron oxide. Orthophosphoric acid can be repeatedly reused in the production cycle until completion of the reaction with iron oxide and full saturation with iron phosphate.

For deeper refinement, sand was also treated with 10% orthophosphoric acid at the temperature of 50°C for 1 h at L : S = 2 : 1, then with 20% sulfuric acid, and after that neutralized. In this case the quartz sand contained 0.0076% iron oxide. However, in most cases this degree of sand purity did not allow production of special purpose glass. Therefore, it was believed expedient to treat the sand with 20% orthophosphoric acid with subsequent dissolution of the emerging iron phosphates in 50% sulfuric acid, and after that to implement the neutralization process.

The application of this method makes it possible to decrease the iron oxide content to 0.008, i.e. by a factor of 2 – 10 versus the initial content (0.095%), providing for a high quality of quartz sand, which can later be used in production of glass for different purposes.

In addition to the sand concentration, the use of this method simplifies the technology and improves the environmental aspect. The color of quartz sand in this case varies from orange to white. The concentration product has a good outward apperance (USSR author's certificate 925878).

This method can be recommended for industrial implementation.

REFERENCES

1. O. K. Botvinkin et al., *Quartz Glass* [in Russian], Stroiizdat, Moscow (1965).